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(71) Applicant (*for all designated States except US*): TELEFONAKTIEBOLAGET LM ERICSSON (publ) [SE/SE]; S-126 25 Stockholm (SE).

(72) Inventor; and

(75) Inventor/Applicant (*for US only*): HOWARD, Joe [IE/IE]; 158 Brandon Road, Drumnagh, Dublin 12 (IE).

(74) Agents: HOFFMANN.EITLE et al.; Arabellastrasse 4, 81925 München (DE).

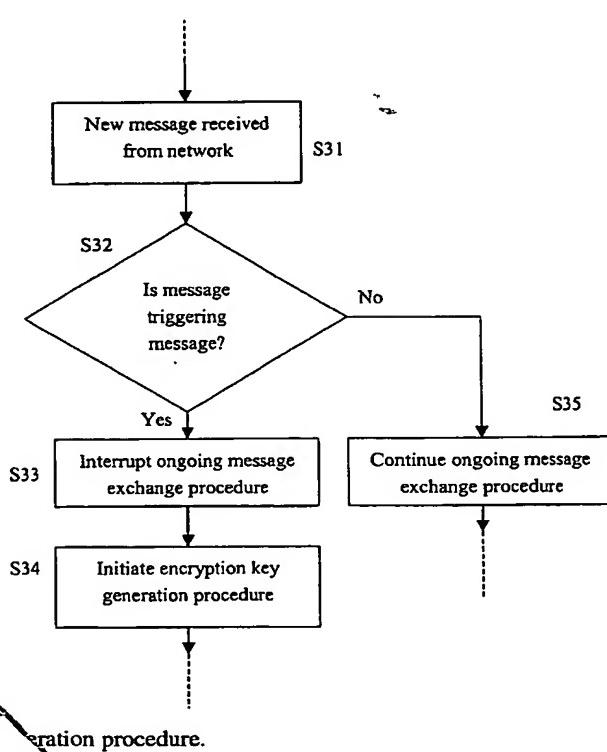
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*[Continued on next page]*

(54) Title: METHOD OF CONTROLLING A NETWORK ENTITY AND A MOBILE STATION



(57) Abstract: A method of controlling a network entity (4, 5) of a mobile communication network and a mobile station (1) is described, as well as a corresponding mobile station and network entity. The network entity (4, 5) and the mobile station (1) are arranged to conduct a plurality of predetermined message exchange procedures in the course of which predetermined messages are exchanged between said network entity (4, 5) and said mobile station (1) depending on the given procedure. The predetermined messages may be encrypted, an encrypted message being any message of which at least a part is encrypted. The network entity (4, 5) and the mobile station (1) are furthermore arranged to conduct one or more encryption key generation procedures in parallel during which the network entity (4, 5) and the mobile station (1) generate and store respective corresponding encryption keys, in order to be able to encrypt and decrypt exchanged messages. The method comprises a step of determining (S21) whether a received message from the mobile station is encrypted. If the received message is encrypted, it is determined (S22) whether a correct encryption key for decrypting said message is available to said network entity (4, 5), and if no correct key is available, a predetermined triggering message is sent to said mobile station (1). The mobile station (1) then interrupts (S33) the procedure in the course of which it sent the encrypted message for which the network entity (4, 5) did not have a correct key, and initiates (S34) an encryption

WO 2004/004199 A1



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Method of controlling a network entity and a mobile station

5 [Field of the invention]

The present invention relates to a method of controlling a network entity of a mobile communication network and a mobile station arranged to communicate with the mobile communication 10 network, and to a network entity and mobile station capable of performing the method.

[Background of the invention]

15 It is known to use encryption in mobile communication systems. In other words, in order to enhance security, messages exchanged over the air-interface between a mobile station and a network entity of a mobile communication network are encrypted, such that the sending side uses an 20 encryption key and the receiving side requires an appropriate key for decrypting the message and thereby discerning the message content. It should be noted that the present specification and claims shall use the term "key" or "encryption key" with respect to keys used both for 25 encryption and decryption. It should also be noted that the term "network entity" shall be used for any network element or combination of network elements that fulfils a given function, such as the function of handling message exchanges with a mobile station. As such, a network entity can be 30 provided by hardware, software or any combination of hardware and software, and can be implemented in one node of a mobile communication network, or spread out over several nodes.

In order to provide both the mobile station and the network 35 entity with appropriate corresponding encryption keys, with which each respective element can decrypt messages received from the other, it is possible to generate one encryption key

in one element, store it in that element, and then transmit it to the other element. However, this is highly disadvantageous, as it is possible that the encryption key sent over the air-interface is intercepted. Consequently it  
5 is preferred to implement respective and corresponding encryption key generation procedures in both the network entity and the mobile station, where corresponding encryption keys (which may be identical, or different from one another, depending on the encrypting scheme used) are respectively  
10 generated in parallel, such that the mobile station and the network entity can each on their own have corresponding or matching encryption keys. The correspondence between the encryption keys is ensured by using corresponding algorithms in the mobile station and network entity. This is well known  
15 and need not be described in more detail.

Furthermore, it is known to start the encryption key generation on the two respective sides using a common seed value, e.g. a regularly changed random or pseudo-random value  
20 broadcast by the mobile communication network to all network entities and listening mobile stations.

The generation of encryption keys is commonly performed at predetermined instances, for example when the mobile station  
25 registers with the mobile communication network. Usually the encryption keys are only generated at certain types of registrations, such as power-on, the transition from one switching entity (e.g. a mobile switching center MSC) to another, or forced registration, in which the network  
30 commands the mobile station to perform a registration.

The communication between a mobile station and a network entity is commonly arranged such that it will use a plurality of message exchange procedures in the course of which  
35 predetermined messages are exchanged between the network entity and the mobile station, the type and number of exchanged messages depending on the given message exchange

procedure. Examples of message exchange procedures are a registration procedure, a link set-up procedure, a link configuration procedure, a call set-up procedure etc. For example, if the mobile station wishes to originate a call, it 5 will send a predetermined call origination request to the network entity, and will then wait for a certain type of response message. In other words, the mobile station will wait until a precise and expected type of response from among a limited number of possible responses, e.g. one that 10 confirms the receipt of the origination request, or one that provides call establishment information, etc. Messages not belonging to the limited group of expected responses will be ignored and the entity will continue to wait for an expected message. Usually, a time-out feature will also be 15 implemented, according to which the mobile station only waits for a predetermined time-out period. After the time-out period expires, the mobile station can e.g. repeat the request, or also enter an idle mode and indicate a corresponding failure to the user of the mobile station, e.g. 20 a call establishment failure in the above mentioned example of initially sending a call set-up request.

The message exchange procedures can be such that some or all exchanged messages in a given procedure are encrypted. It may 25 be noted that the term "encrypted message" refers to any message of which at least a part is encrypted. For example, an encrypted message can be a message that contains a (first) unencrypted part and a (second) encrypted or encryptable part. As an example, a message could be contained in one or 30 more packets, each having a header and a payload section, where the header is not encrypted and the payload section is.

An example of rules governing the use of encryption in the communication between a mobile station and the network entity 35 of a mobile communication network is provided by standard TIA/EIA-136 published by the Telecommunication Industry Association. In TIA/EIA-136 a mode called enhanced privacy

and encryption (EPE) is provided, which is an authentication-related capability that adds confidentiality to signals transmitted over a time division multiple access (TDMA) digital channel between a base station of a mobile

5 communication network and a mobile station. The encryption, if supported by the network entity and the mobile station, is mandatory and is automatically activated, pending hand shaking procedures between the mobile station and base station.

10

TIA/EIA-136 specifies that with EPE encryption is automatically activated after authentication is complete if both the mobile station and the system support the feature. TIA/EIA-136 further specifies that support for EPE is

15 mandatory for mobile stations that adhere to protocol version 4, but mobile stations that adhere to lower protocol versions may also support EPE.

The type of encryption applied together with the type of data 20 encrypted, is controlled and authorized by means of encryption domains. Encryption domains define the level and type of encryption desired, the manner in which the encryption shall be applied and the data eligible for encryption. The encryption domain identifies portion of 25 FACCH/SACCH (Fast Associated Control Channel/Slow Associated Control Channel) messages on digital or analogue channels that are subject to encryption, together with the encryption algorithm to be applied. Previously, for the introduction of EPE, a single encryption domain had been defined, namely, 30 Domain-A. This allowed the encryption of a portion of the messages on the FACCH/SACCH together with the payload (circuit-switched speech or data) on a digital traffic channel and a portion of the messages on the analogue voice channel. This information, defined by the Domain-A encryption 35 domain, is eligible for encryption by the Domain-A encryption algorithms only. The encryption of payload (circuit-switched speech or data) by a Domain-A encryption is commonly known as

voice privacy or the encryption of layer 3 messages by a Domain-A encryption is commonly known as Domain-A message encryption.

- 5 EPE introduces a new encryption domain, namely Domain-B. The Domain-B encryption domain again defines a portion of the messages on the FACCH/SACCH digital traffic channel, a portion of messages on the digital control channel together with payload (circuit-switched speech or data). This  
10 information, defined by the Domain-B encryption domain is eligible for encryption by Domain-B encryption algorithm.

A single encryption algorithm known as Scema is introduced as the domain-B encryption algorithm, producing encryption keys  
15 for the encryption of both circuit-switched speech/data on a digital traffic channel and Layer3 messages (both on digital traffic and digital control channels), as defined by TIA/EIA-136.

- 20 The Domain-B encryption applies to the following:

- Domain-B message encryption for user signalling on the digital control channel. The DCCH-encryption key (DCCH = Digital Control Channel), generated in both the mobile station and the network entity, is applied to specific Layer3 TIA/EIA-136 DCCH messages.
- Domain-B message encryption for user signalling on the digital traffic channel. The DTC-encryption key, generated in both the mobile station and the network entity is applied to specific Layer3 TIA/EIA-136 DTC-messages.
- Domain-B encryption on the digital traffic channel for both circuit-switched voice and data. The DTC-encryption key generated in both the mobile station and the network entity is applied to circuit-switched voice and data.

EPE on the DCCH is activated at registration. Both the mobile station and system generate the Domain-B encryption keys, based on among other information, the currently available

- 5 value of a parameter called RAND (a random variable which is broadcast on the control channel) and other information. The generation of the keys is performed on both the mobile station side and the network side in parallel. This ensures that the encryption keys are "synchronized", where  
10 "synchronized" means that the keys on either side are in correct correspondence to one another, such that each side can decrypt the messages encrypted by the other side. The generated encryption keys are stored in both the mobile station and the network.

15

- The encryption keys are only generated at certain types of registration, including power-on, transition to a new switching entity (MSC), and forced registration, where the network entity informs the mobile station whether EPE should  
20 be activated via the registration accept message.

- Once activated, the mobile shall encrypt a portion of RACH messages (RACH = Random Access Channel) with the generated encryption key. Layer3 messages subject to Domain-B  
25 encryption on the reverse digital control channel are:  
Origination, Page Response, R-data and Serial Number.

- Layer3 messages subject to Domain-B encryption on the forward digital control channel are: Analogue Voice Channel  
30 Designation, Digital Traffic Channel Designation, Message Waiting, Page, R-data, Registration Accept and User Alert messages.

- On reception of a message on the RACH from a mobile station  
35 camped on a DCCH, the network entity will determine whether a message is encrypted or not with Domain-B encryption, by using the message encryption indicator field of the Layer 2

- extension header. If the message is not encrypted, then processing of the message will occur as implemented in the given system. If the encryption indicator field indicates that a message is encrypted with Domain-B encryption,
- 5      Domain-B DCCH-encryption key shall be retrieved from its storage location, e.g. a visitor location register VLR, where the encryption is stored together with other information related to the subscriber using the mobile station that is in communication with the network entity. Once the Domain-B
- 10     DCCH-encryption key is available, the message shall be decrypted and processing of the message is completed as implemented in the network.

The terms Layer3 and Layer2 used above refer to different levels specified by TIA/EIA-136, and are not to be understood as layers within the meaning of the OSI model.

[Object of the invention]

- 20    The object of the invention is to improve the operation of a network entity of a mobile communication network and a mobile station that are able to exchange encrypted messages, and which both are arranged to conduct respective encryption key generation procedures in parallel.

25

[Summary of the invention]

This object is solved by the method of claim 1, the mobile station of claim 8 and the network entity of claim 10.

- 30    Advantageous embodiments are described in the dependent claims.. In accordance with the present invention, the network entity and mobile station are arranged to operate such that if the network entity receives a message from the mobile station, it determines whether the received message is encrypted, and if the received message is encrypted, it determines whether a correct encryption key for decrypting the message is available to the network entity. In other
- 35

words, it is determined whether any encryption key is available, and if one is available, it is determined whether this key is the correct one, which can be recognised by analysing the decryption result. In other words, if the 5 decryption is not successful, then the used key is evidently not correct.

The network entity is furthermore arranged such that if no correct key is available, then a predetermined triggering 10 message is sent to the mobile station. The mobile station is arranged such that upon receiving the predetermined triggering message, it interrupts the message exchange procedure currently active, i.e. the procedure in the course of which it sent the encrypted message for which the network 15 entity did not have a correct key, and initiates an encryption key generation procedure. Through the parallel encryption key generation procedures, the mobile station and network entity in parallel generate matching or corresponding encryption keys and are thereby again "synchronized" with 20 respect to encryption, i.e. both have the correct encryption key for decryption encrypted messages sent by the other side.

The specific advantage of the present invention lies in the fact that the mobile station does not wait until the ongoing 25 message exchange procedure comes to an end by itself, e.g. by a time-out. Namely, it has been recognised by the inventor of the present invention that under conventional circumstances, if for any reason the network entity can not obtain a correct encryption key for decrypting an encrypted message received 30 from the mobile station, the network entity can not respond appropriately, such that the mobile station will continue the ongoing message exchange procedure that sent the encrypted message, i.e. would wait for the expected response to the encrypted message, which expected response, however, can not 35 be provided by the network entity, as it can not decrypt the message. During this time of continuing the ongoing message exchange procedure, i.e. waiting, a conventional mobile

station will disregard any other communications or messages from the network entity, even a message indicating that the mobile station should re-register. Such a re-registration will only occur when the conventional mobile station has

5 returned to the idle mode after having finally abandoned the message exchange procedure. The time until the conventional mobile station abandons the message exchange procedure can last very long, as it does not only include the time-out period, because it is also possible that after a first expiry

10 of the time-out period, the mobile station will reinitiate the message exchange procedure using encrypted messages, to which the network entity can not respond, such that several time-out periods may pass before the conventional mobile station will enter an idle mode, in which it can re-register

15 and thereby perform an encryption key generation procedure in parallel with the network entity.

Such a disadvantage is completely obviated by the teaching of the present invention. Namely, if the network entity is

20 unable to decrypt a received encrypted message, it sends a triggering message to the mobile station, whereupon the mobile station interrupts the ongoing message exchange procedure, i.e. does not wait until a time-out occurs, in order to immediately initiate an encryption key generation

25 procedure in parallel with the network entity. Thereby, an unnecessary loss of time for performing encryption key generation procedures in the network entity and mobile station is avoided.

30 Preferably, the messages are arranged such that they have a first part and a second part, where the first part is an unencrypted part that is not allowed to be encrypted (i.e. always unencrypted) and a second part that is encryptable. Then, the unencrypted part may contain an encryption

35 indication of whether the second part is encrypted or not, and the step of determining whether a received message is

encrypted is performed by analysing the encryption indication.

According to another preferred embodiment, when the messages  
5 are arranged such that the first part contains a message type identifier identifying the type of the message (e.g. link set-up request, call set-up request, etc.), the network entity is arranged to identify the message type of the received message from the message type identifier, and to  
10 determine whether the identified message type belongs to a predetermined category, and to only send the triggering message to the mobile station if the message type falls into the predetermined category. For example, the predetermined category can be that the received message is a set-up  
15 request. Then, the triggering message will only be sent if the received encrypted message for which no correct encryption keys available, is a set-up message. According to another preferred embodiment, the encryption key generation procedures used in the network entity and the mobile station  
20 comprise obtaining an encryption base value, such as the seed value mentioned in the introduction, for generating corresponding encryption keys based thereon. Preferably, the encryption base value is a regularly changed value that is broadcast by the network to listening mobile stations, such  
25 as the above mentioned random or pseudo-random value RAND.

According to another preferred embodiment, the encryption key generation procedure is conducted as a part of a registration procedure for the mobile station with the network entity. In  
30 other words, the initiation of the encryption key generation procedure comprises initiating a registration or re-registration procedure of the mobile station with the mobile communication network to which the network entity belongs, in the course of which parallel encryption key generation  
35 procedures are conducted in the network entity and the mobile station.

## [Brief description of drawings]

Further aspects and advantages of the present invention shall become apparent from the study of the following detailed

5 description of preferred embodiments of the invention, which are given as examples and are not intended to be limiting, where the description makes reference to the attached drawings in which:

10 Fig. 1 shows a schematic representation of a mobile station of an embodiment of the present invention;

15 Fig. 2 shows a flowchart of a procedure conducted in a network entity in accordance with an embodiment of the present invention;

Fig. 3 shows a flowchart of a routine conducted in a mobile station according to an embodiment of the present invention;

20 Fig. 4 shows a schematic representation of a mobile station and a network entity according to an embodiment of the present invention; and

25 Fig. 5 shows a schematic representation of a message containing a first unencrypted part and a second encryptable part.

## [Detailed description of embodiments]

30 Fig. 1 shows a schematic block diagram of a mobile station 1 arranged to operate according to the present invention. Fig. 1 shows an antenna 11, a transmitting and receiving part 12, and a signal processing section 13. The signal processing section 13 comprises a processor 132 and a memory 131. The processor 132 is indicated as comprising an encryption key generator 1321, a message encryptor/decryptor 1322 and a

controller 1323 for controlling the operation of the mobile station. It may be noted that the mobile station will generally contain further conventional features, such as a microphone, loudspeaker, display, keyboard and other well known elements, which are not shown, as they have no relevance for the present description.

The encryption key generator 1321, message encryptor/decryptor 1322 and controller 1323 are shown as being software components executed by the processor 132. However, it may be noted that they could also be provided as separate hardware components, or as any suitable combination of hardware and software.

The encryption key memory 131 can be provided in any suitable or desirable way, e.g. as a RAM. The signal processing section 13 can comprise further memory elements, such as ROMs for storing software and other information, where such additional memory elements are not shown for simplicity.

According to the embodiment shown in Fig. 1, the encryption key generator 1321 serves to generate an encryption key, which is then stored in the encryption key memory 131. The message encryptor/decryptor 1322 encrypts messages sent to the mobile communication network by the mobile station 1, and decrypts messages received from the mobile communication network, by using one or more stored encryption keys. The contact with the mobile communication network is established by the transceiver 12 and antenna 11, as is well known, such that a further description is not necessary here.

According to the embodiment of Fig. 1, the controller 1323 is arranged to control the operation of the mobile station 1, and is specifically arranged to perform one or more predetermined message exchange procedures with the mobile communication network, such as a link set-up, call set-up, etc. In the course of such message exchange procedures, the

mobile station sends predetermined types of messages (such as a call set-up request) and waits for predetermined corresponding types of response messages from the communication network (such as a call set-up acknowledgement). Furthermore, the controller 1323 is arranged to identify the receipt of a predetermined unencrypted triggering message from the mobile communication network during the course of an ongoing message exchange procedure, and is arranged to interrupt the ongoing message exchange procedure in response to receiving the predetermined unencrypted triggering message, and to then initiate an encryption key generation procedure.

This can also be seen in the flow chart of Fig. 3, which shows a part of a routine executed by the controller 1323. In step S31, the receipt of a new message from the mobile communication network is detected. Subsequently, in step S32 it is determined whether the received message is of a predetermined type and is a triggering message. If it is a triggering message, then the procedure goes to step S33, in which the ongoing message exchange procedure is interrupted, and whereupon step S34 is conducted, in order to initiate an encryption key generator procedure, e.g. as a part of a registration or re-registration procedure of the mobile station with the mobile communication network. On the other hand, if step S32 determines that the received is not the predetermined triggering message, then the procedure branches to step S35, in which the ongoing message exchange procedure is continued.

30

Fig. 4 shows a schematic representation of a network entity and a mobile station 1. In the example of Fig. 4, the network entity consists of a base station part 4 and a traffic control part 5, where said base station part 4 comprises a base transceiver station (BTS) 41 and a base station controller (BSC) 42. The traffic control unit 5 comprises a mobile switching network (MSC) 51 and a data base 52, which

comprises a home location register (HLR) and visitor location register (VLR). The network entity thereby has the structure known from GSM, such that a further description is not necessary here. It may be noted that the base station controller 42 may be connected to a plurality of base transceiver stations, and that the mobile switching center 51 may be connected to a plurality of base station parts (i.e. a plurality of base station controllers). Also, the mobile switching center 51 is typically connected to further network entities, such as gateways to other networks, which is well known in the art and not shown in Fig. 4 for simplicity.

According to the embodiment of Fig. 4, the network entity provided by base station part 4 and traffic control part 5 comprises an encryption key generator 511 located in the mobile switching center 51, where the data base 52 acts as an encryption key memory for storing encryption keys generated by the encryption key generator 511. Furthermore, a message encryptor/decryptor 421 is provided in the base station controller 42 for encrypting messages sent to the mobile station 1 and decrypting messages received from the mobile station 1 using an encryption key stored in the database 52. It may be noted that the generated encryption keys are preferably stored in the VLR part of the database 52, in association with other data belonging to the subscriber using the mobile station 1.

The mobile switching center acts as a controller for controlling the communication between the network entity 4, 5 and the mobile station 1, where the MSC 51 is arranged to determine whether messages received from the mobile station 1 are encrypted or not, and if a received message is encrypted, determining whether a correct key for decrypting the message is available or not. If no correct key is available, then a predetermined unencrypted triggering message is sent to the mobile station 1, for triggering an immediate encryption key generation procedure in the mobile station 1, as explained

previously with respect to Figs. 1 and 3. An example of a routine executed by controller 51 is shown in the flow chart of Fig. 2. In step S21 it is determined whether a message received from the mobile station 1 is encrypted or not. Step 5 S21 can be implemented in a variety of ways. For example, it is possible that the mobile station 1 sends an unencrypted indication signal to the network entity, said unencrypted indication signal informing the network entity that all subsequent messages sent by the mobile station are encrypted.

10 In this case, step S21 simply consists in determining that the message is such a subsequent message. Preferably, the message structure is as shown in the example of Fig. 5, namely a message 6 consists of a first part 61, which is not allowed to be encrypted, and a second part 62, which is

15 encryptable. The unencryptable part 61 preferably contains a message type identifier 610 that identifies the type of the message (e.g. as a call set-up request), and an encryption indication 611 that indicates whether the encryptable part 62 is in fact encrypted or not. As such, the encryption indication 611 can be a single bit, where one bit value indicates encryption and the other lack of encryption. Naturally, the encryption indication 611 can also be more complicated and contain further information.

20

25 In this case, step S21 in Fig. 2 consists in examining or analysing the encryption indication 611. If the message is encrypted, step S22 determines whether a correct key is available. For example, this can consist in determining whether any key is available in the database 52 for the

30 mobile station 1 (the subscriber using mobile station 1), and if not, then this already indicates that no correct key is available. However, it is also possible that a key is available, but that a decryption attempt for the received message leads to the conclusion that the key is not correct,

35 as it does not lead to a successful decryption.

There are several reasons why a correct encryption key may not be available for decrypting the received message. For example, if the encryption keys are stored in the VLR in association with other subscriber data, it is possible that

5 they are deleted in the course of regular "re-cycling" operations conducted by the operator of the networks, in which subscriber records are deleted if the corresponding mobile station has not registered with the network within an operator-defined period of time. It is possible that an

10 active mobile station has disabled the periodic registration function, or that it has "missed" a registration due to temporary communication problems. If the subscriber record has been re-cycled, then the encryption key is lost, and if the mobile station then proceeds to send an encrypted

15 message, e.g. a call set-up request, then the network entity can not decrypt the message and respond accordingly.

Returning to Fig. 2, if the outcome of step S22 indicates that no correct key is available, then a procedure S23 is initiated, in which a predetermined unencrypted triggering message is sent to the mobile station, which makes the mobile station conduct an immediate encryption key generation procedure. In the course of this encryption key generation procedure, e.g. a registration or re-registration, the

25 network entity also performs an encryption key generation procedure in parallel, such that matching or corresponding encryption keys are available both in the mobile station and the network entity, and encrypted messages can again be exchanged without any problems.

30 In the example of Fig. 4, the message encryptor/decryptor 421 and the encryption key generator 511 are shown as software routines implemented in the base station controller 42 and mobile switching center, respectively. However, it may be

35 noted that the encryption key generator 511 and the message encryptor/decryptor 421 can also be provided as separate hardware elements or as any suitable combination of hardware

and software. Moreover, the structure of the example of Fig. 4 is only an example, and the functional elements can also be provided otherwise, e.g. spread out over all of the shown nodes or provided in other nodes. Moreover, the database 52 associated with the mobile switching center 51 can be used as an encryption key memory, but an encryption key memory can also be provided in association with any other element shown in Fig. 4. Furthermore, although the example of Fig. 4 is related to GSM, the concept of the present invention is not restricted to GSM mobile communication networks, but can be used in the context of any mobile communication system in which encrypted messages are used, and in which encryption key generation procedures are implemented on the mobile station side and the network side.

15

Now a preferred embodiment of the present invention shall be explained in the context of the standard TIA/EIA-136 discussed in the introduction to the application. It may be noted that the discussion of TIA/EIA-136 in the introduction is herewith incorporated into the disclosure of the invention.

On reception of an encrypted RACH message from the mobile station, the network entity will be able to determine that the message is encrypted via the Layer2 header information (as e.g. shown in Fig. 5). If the Bomain-B DCCH-encryption key is not available and the network entity is unable to decrypt the message, it can use a message indicator (such as the indication 610 shown in Fig. 5) to determine what message the mobile has sent as the message type is not encrypted.

As one possibility, the network entity can reject the service requested by the message, regardless of the message type, and send an unencrypted layer 3 message to the mobile station, stating that the reason for rejection is a "system-related cryptography mismatch". Preferably, the message indicating the system-related cryptography mismatch is only sent for

messages of a certain type. In other words, it is preferably analysed whether the message type of an encrypted message that is not decryptable belongs to a predetermined category (e.g. the category defined by all set-up messages), and the 5 message indicating system-related cryptography mismatch is only sent if the received encrypted message belongs to the predetermined category.

More specifically, examples of received encrypted messages 10 from the mobile station in response to which the network entity can send a message indicating system-related cryptography mismatch are the following Layer3 messages: Origination Message, Page Response Message and R-data Message. In response to the Origination Message, the network 15 entity can build a Reorder/Intercept message including the indication "system-related cryptography mismatch" in the Cause Extension Information Element. In response to the Page Response Message, the network entity can send a Release message, which also includes the "system-related cryptography 20 mismatch" in the Cause Extension Information Element. Finally, in response to the R-data message, the network entity can send a Reorder/Intercept message, also including the "system-related cryptography mismatch" in the Cause 25 Extension Information Element. Alternatively, a R-data reject message can also be sent.

On reception of one of the above described response messages, which are all examples of triggering messages, the mobile station is arranged to examine the received cause value (the 30 Cause Extension Information Element). If the reason is "system-related cryptography mismatch", the mobile station is arranged (programmed) to immediately interrupt the ongoing procedure (e.g. interrupt waiting for the appropriate response to the sent message), and declaring a Forced 35 Registration condition, in order to invoke a Registration procedure. In the Registration procedure, a parallel encryption key generation procedure is conducted in the

mobile station and the network entity. The registration procedure is e.g. specified in TIA/EIA-136-123: TDMA third generation wireless digital control channel Layer3.

- 5 In order to implement the above described example in context of TIA/EIA-136, the appropriate specification may be updated as follows: The Cause Extension IE should be updated to contain the rejection reason "system-related cryptography mismatch". The Waiting for Order State should be updated to
- 10 allow the mobile station to declare a Forced Registration condition and invoke the Registration procedure on reception of a Release message, specifying the reason for rejection as "system-related cryptography mismatch". The Origination Proceeding State should be updated to allow the mobile
- 15 station to declare a Forced Registration condition and invoke the Registration procedure on reception of a Reorder/Intercept message specifying the reason for rejection as "system-related cryptography mismatch". The Originated Point-to-Point Teleservice Proceeding should be updated to
- 20 allow the mobile station to declare a Forced Registration condition and invoke the Registration procedure on reception of a Reorder/Intercept message, specifying the reason for rejection as "system-related cryptography mismatch".

Claims

1. A method of controlling a network entity (4, 5) of a  
5 mobile communication network and a mobile station (1),  
wherein said network entity (4, 5) and said mobile  
station (1) are arranged to conduct a plurality of  
predetermined message exchange procedures in the course  
of which predetermined messages are exchanged between  
10 said network entity (4, 5) and said mobile station (1)  
depending on the given procedure, where said  
predetermined messages may be encrypted, an encrypted  
message being any message of which at least a part is  
encrypted, and where said network entity (4, 5) and said  
15 mobile station (1) are arranged to conduct one or more  
encryption key generation procedures during which the  
network entity (4, 5) and the mobile station (1)  
generate and store respective corresponding encryption  
keys, in order to be able to encrypt and decrypt  
20 exchanged messages, where said method comprises the  
steps of:
  - if said network entity (4, 5) receives a message from  
said mobile station (1), determining (S21) whether said  
received message is encrypted,
  - if the received message is encrypted, determining  
25 (S22) whether a correct encryption key for decrypting  
said message is available to said network entity (4, 5),  
and if no correct key is available, sending (S23) a  
predetermined triggering message to said mobile station  
30 (1),
    - upon receiving said predetermined triggering message,  
said mobile station (1) interrupting (S33) the procedure  
in the course of which it sent the encrypted message for  
which the network entity (4, 5) did not have a correct  
key, and initiating (S34) an encryption key generation  
35 procedure.

2. A method according to claim 1, wherein said messages are arranged such that they have a first part (61) and a second part (62), said first part (61) being an unencrypted part that is not allowed to be encrypted, and said second part (62) being encryptable.  
5
3. A method according to claim 2, wherein said messages are arranged such that said first part (61) contains an encryption indication (611) of whether said second part (62) is encrypted or not; and said determining of whether the second part (62) of said received message is encrypted or not is achieved by analysing said encryption indication (611).  
10
- 15 4. A method according to claim 2 or 3, wherein said messages are arranged such that said first part (61) contains a message type identifier (610) identifying the type of the message, and after having received a message from said mobile station (1), said network entity (4, 5) identifies the message type of said received message from the message type identifier (610) and determines whether said identified message type belongs to a predetermined category, and sends said predetermined triggering message to said mobile station (1) only if the message type of said received message falls into said predetermined category.  
20  
25
5. A method according to one of the preceding claims, wherein said one or more encryption key generation procedures comprise obtaining an encryption base value (RAND) commonly available to said network entity (4, 5) and said mobile station (1) at the time of conducting said encryption key generation procedure, and generating corresponding encryption keys in said network entity (4, 5) and said mobile station (1) on the basis of said encryption base value (RAND).  
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35

6. A method according to claim 5, wherein said encryption base value (RAND) is a regularly changed value that is broadcast by said network to listening mobile station (1)s.

5

7. A method according to one of the preceding claims, wherein said encryption key generation procedure is conducted as a part of a registration procedure of said mobile station (1) with said network entity (4, 5).

10

8. A mobile station (1) arranged to operate with a mobile communication network, comprising

15 an encryption key generator (1321) for generating a encryption key,

an encryption key memory (131) for storing a generated encryption key,

20 a message encryptor/decryptor (1322) for encrypting messages sent to said mobile communication network and decrypting messages received from said mobile communication network using a stored encryption key, an encrypted message being any message of which at least a 25 part is encrypted,

30 a controller (1323) for controlling the operation of said mobile station (1), said controller being arranged to perform one or more predetermined message exchange procedures with said mobile communication network, in the course of which said mobile station (1) sends predetermined types of messages to said mobile communication network and waits for predetermined corresponding types of messages from said mobile 35 communication network, said controller furthermore being arranged to identify the receipt of a predetermined triggering message from said mobile communication

network during the course of an ongoing message exchange procedure, and in response to said predetermined triggering message interrupting the ongoing message exchange procedure and initiating an encryption key generation procedure.

5

9. A mobile station (1) according to claim 8, wherein said controller (1323) is arranged to conduct said encryption key generation procedure as a part of a registration procedure of said mobile station (1) with said mobile communication network.

10

10. A network entity (4, 5) of a mobile communication network arranged to communicate with a mobile station (1), comprising:

15

an encryption key generator (511) for generating a encryption key,

20

an encryption key memory (51) for storing a generated encryption key,

25

a message encryptor/decryptor (421) for encrypting messages sent to said mobile station (1) and decrypting messages received from said mobile station (1) using a stored encryption key, an encrypted message being any message of which at least a part is encrypted,

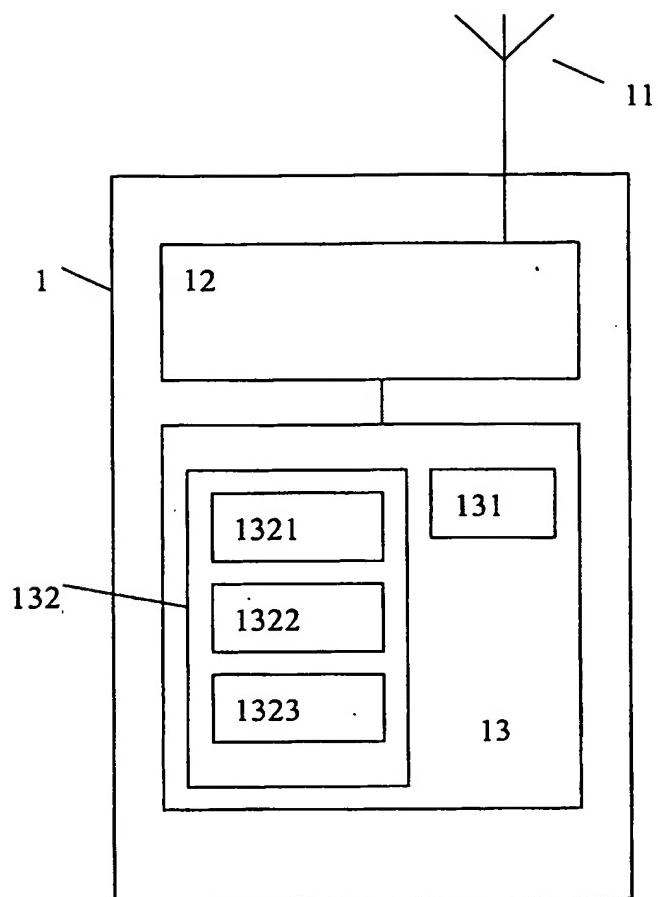
30

a controller (51) for controlling the communication between said network entity (4, 5) and said mobile station (1), said controller (51) being arranged to determine whether messages received from said mobile station (1) are encrypted or not, and if a received message is encrypted, determining whether a correct key for decrypting said message is available to said network entity (4, 5), and if no correct key is available, sending a predetermined triggering message to said

35

mobile station (1) for triggering an immediate encryption key generation procedure in said mobile station (1).

1/5

**Fig. 1**

2/5

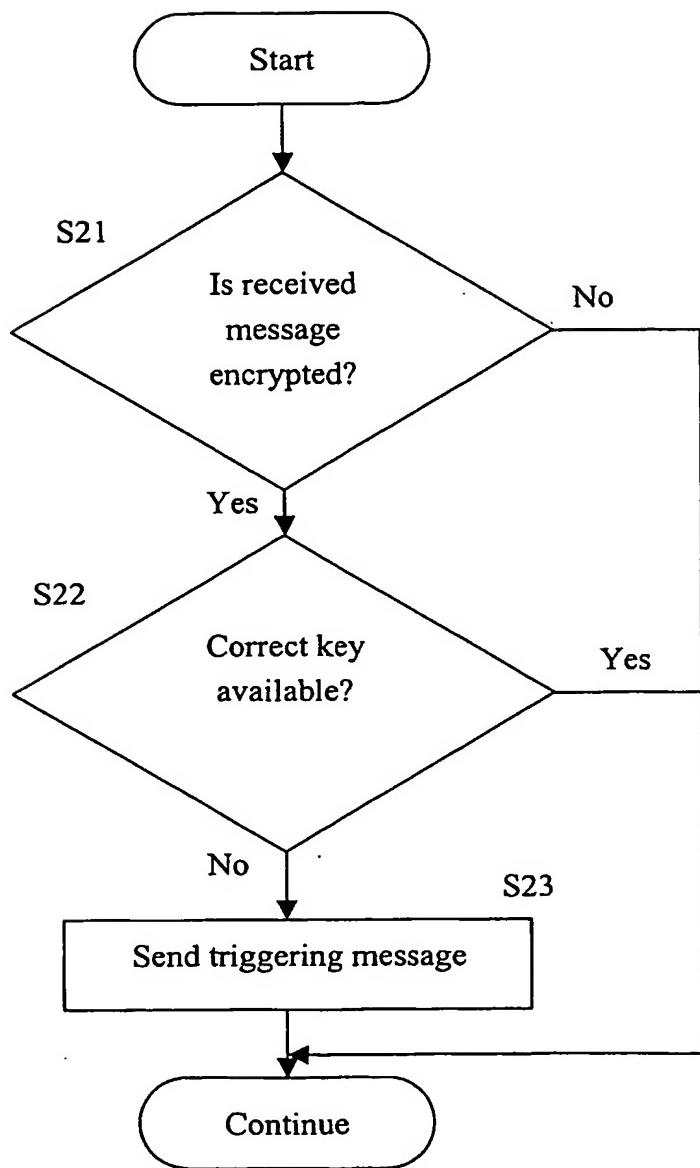
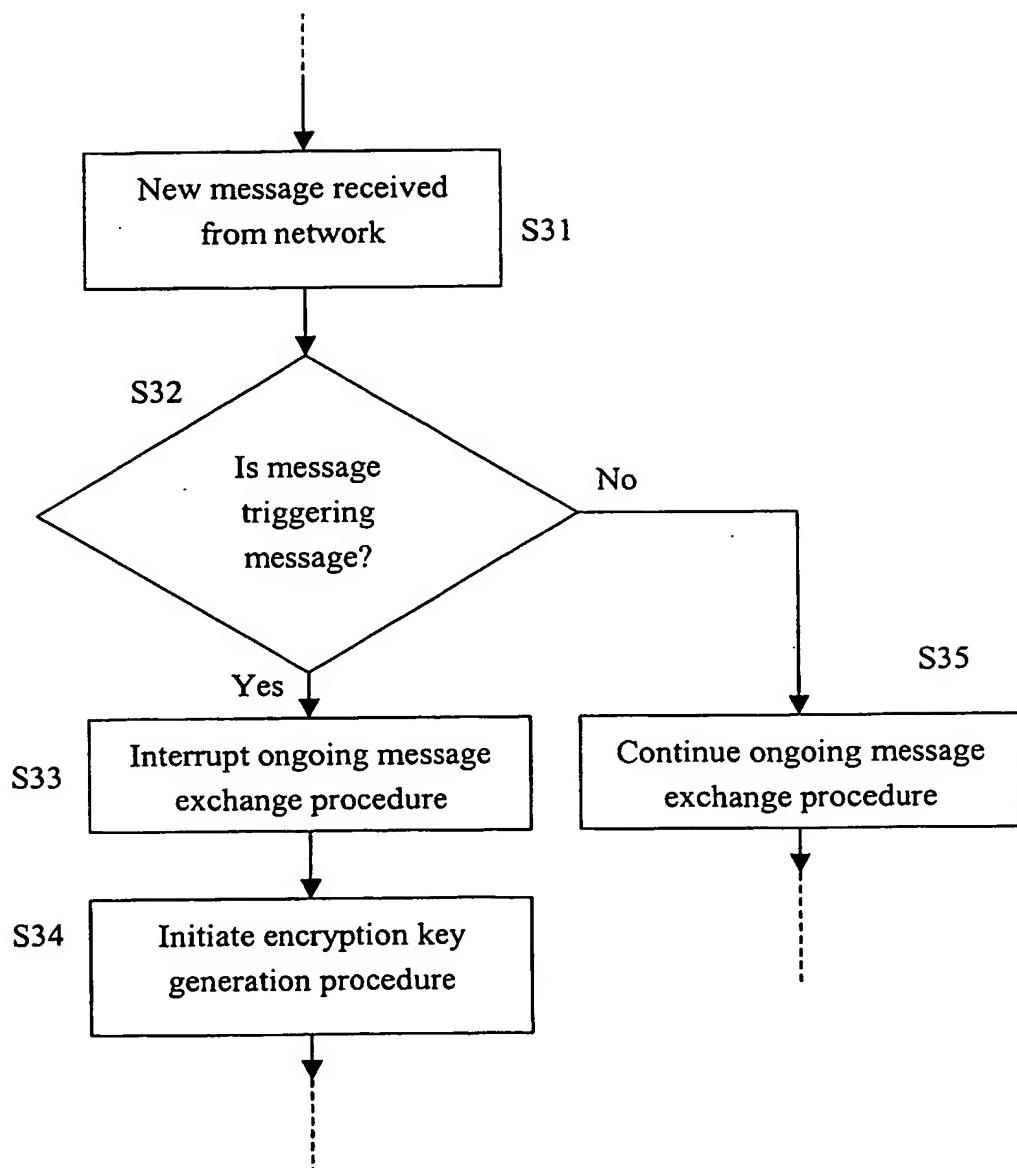


Fig. 2

3/5

**Fig. 3**

4/5

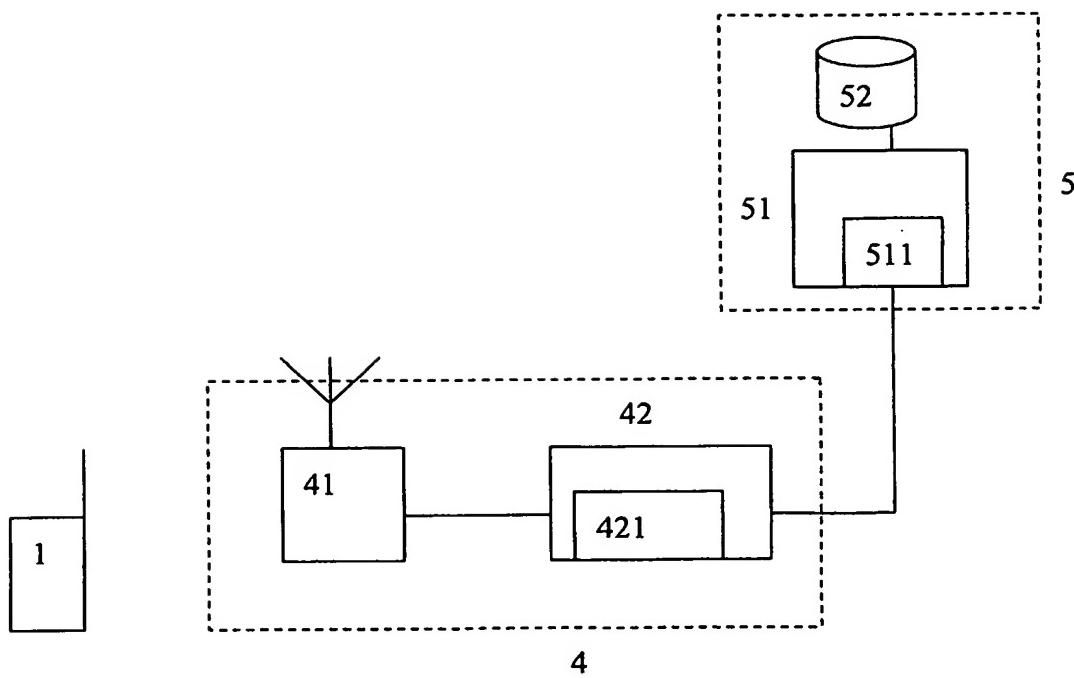
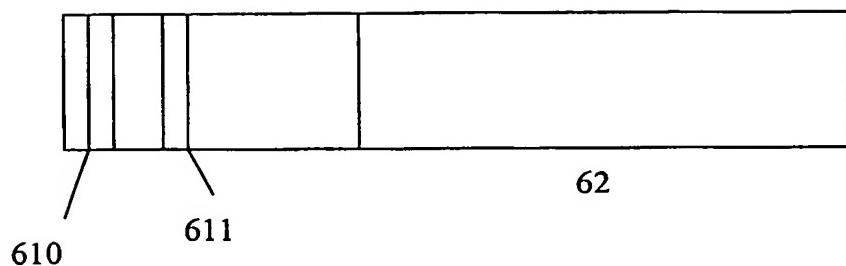


Fig. 4

5/5

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61



**Fig. 5**

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/02/07076

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H04L9/32 H04L9/08 H04Q7/38

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H04L H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the International search (name of data base and, where practical, search terms used)

EPO-Internal

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>"TDMA Third Generation Wireless Authentication, Encryption of Signaling Information/User Data, and Privacy"  TIA/EIA STANDARD, 'Online!  31 March 2000 (2000-03-31), pages 1-62,  XP002231163  USA  Retrieved from the Internet:  &lt;URL:ftp://ftp.tiaonline.org/uwc136/136-5  10-B.pdf&gt; 'retrieved on 2003-02-14!  *hole document*</p> <p>---</p> <p style="text-align: center;">-/--</p>	1-10

 Further documents are listed in the continuation of box C. Patent family members are listed in annex.

## ° Special categories of cited documents :

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the International filing date
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Date of the actual completion of the International search

14 February 2003

Date of mailing of the International search report

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## Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel: (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Apostolescu, R

## INTERNATIONAL SEARCH REPORT

onal Application No

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## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 241 598 A (RAITH KRISTER A) 31 August 1993 (1993-08-31) column 7, line 36 -column 8, line 52 column 10, line 29 - line 40 column 11, line 26 - line 37 column 11, line 61 - line 68 column 12, line 47 - line 50 column 13, line 18 - line 35 column 15, line 55 -column 16, line 20 column 17, line 36 - line 59 column 23, line 27 - line 47 ----	1-10
A	US 5 091 942 A (DENT PAUL) 25 February 1992 (1992-02-25) column 11, line 26 -column 12, line 7 column 17, line 7 -column 19, line 47 column 21, line 44 -column 25, line 3 -----	1-10

**INTERNATIONAL SEARCH REPORT**

Final Application No

PCT/02/07076

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US 5241598	A 31-08-1993	NONE		
US 5091942	A 25-02-1992	AU 645228 B2 AU 8442991 A CA 2087722 A1 CN 1059058 A ,B GB 2261579 A ,B HK 30295 A JP 2656153 B2 JP 6500900 T KR 9607808 B1 MX 9100139 A1 NZ 238653 A WO 9202087 A1		06-01-1994 18-02-1992 24-01-1992 26-02-1992 19-05-1993 17-03-1995 24-09-1997 27-01-1994 12-06-1996 28-02-1992 25-03-1994 06-02-1992